# MLS Observations of Composition in the Long-Lived Stratospheric Plume from the 2017 British Columbia Pyroconvection Event

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# The 2017 British Columbia Pyroconvection Event



- On 12 August, 2017, smoke and other combustion products from intense wildfires in British Columbia and Washington state (the Pacific Northwest Event, PNE) were lofted to the tropopause by pyroconvection and then rapidly advected northward and into the stratosphere.
- This plume, first observed by MLS a day later over northwest Canada, was extraordinary both its unprecedented trace gas mixing ratios and in its persistent coherence as a set of compact airmasses that were radiatively lofted to an altitude of at least 23 km (31 hPa) and advected around the globe over the ensuing >100 days.
- Pat Kablick will talk about the radiative lofting of the plume in about 20 minutes.
- Here, we will focus on the composition signatures of the plume in MLS observations.
- Such events are rare (one or two, depending on the metric) in the 15-year Aura period, but they may become more common with climate change and could be relevant for the understanding of nuclear winter scenarios.

# Lower-Strat MLS Products for PyroCb Plume Studies

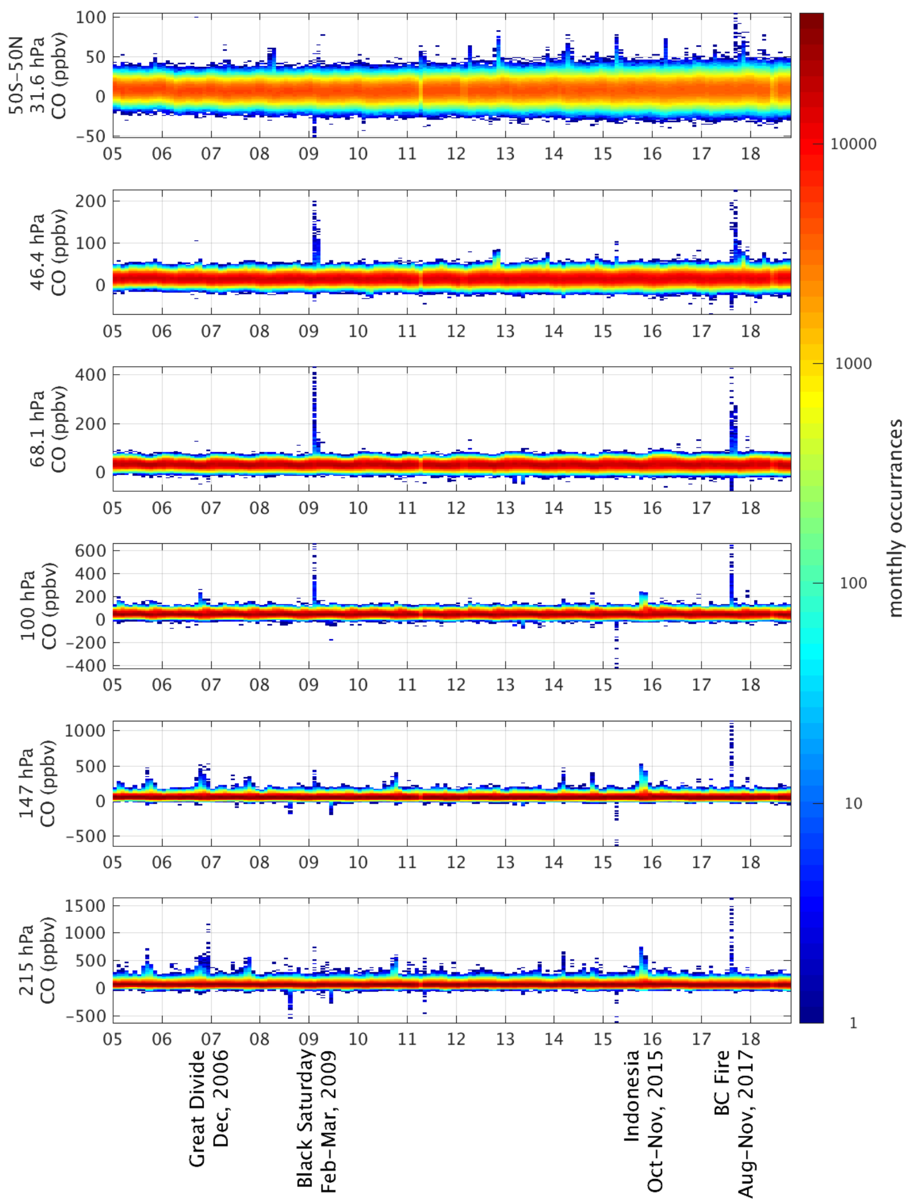


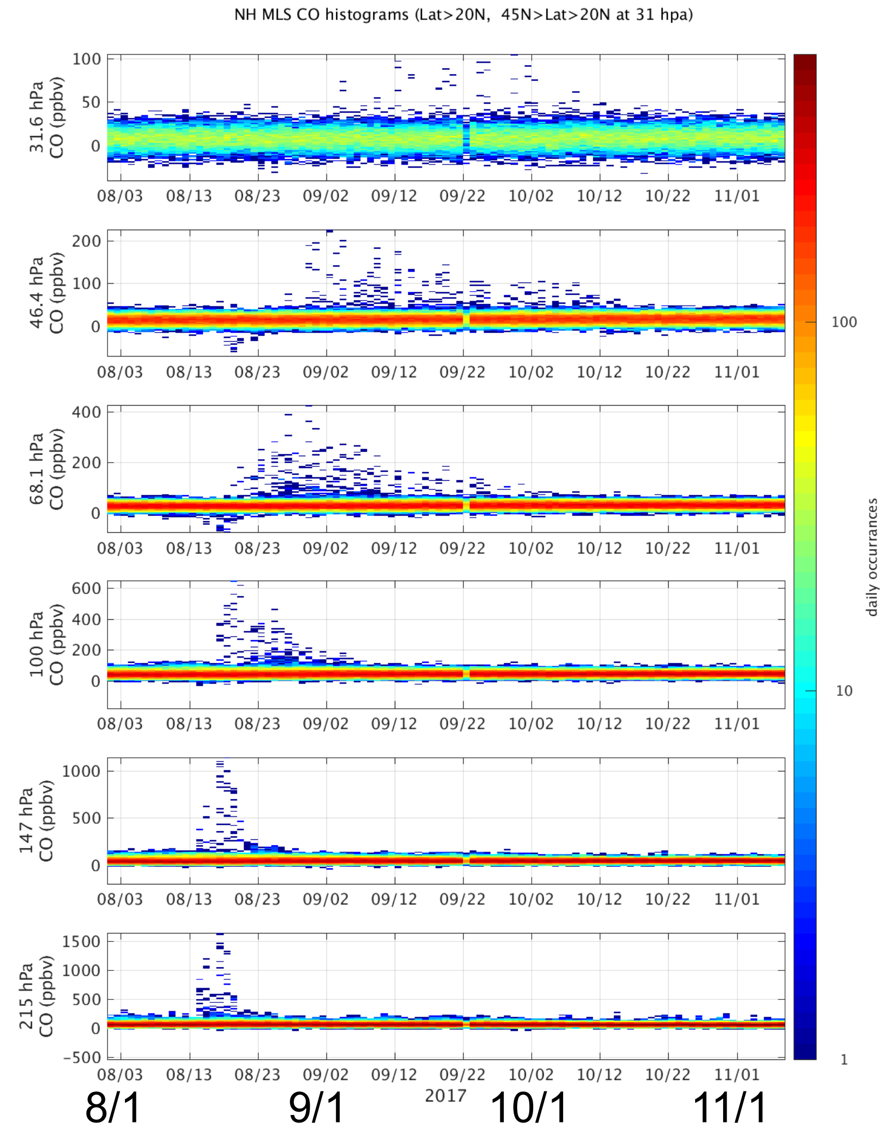
DOWNLOAD AND READ THE DATA QUALITY DOCUMENT

| | LS VAvk FWHM | LS HAvk FWHM | Useful Vertical range | Precision | Estimated Accuracy | Retrieval resolution |
|---|---|---|---|---|---|---|
| CO | 5 km | 425 km | 215-0.0046 hPa | 9—14 ppbv | ~50% | 6/decade |
| H2O | 3.1 km | 190 km | 316—0.002 hPa | 5—10% | 4—9% | 12/decade |
| O3 | 2.5 km | 350 km | 261—0.02 hPa | 60 ppbv + 3% | 100 ppbv + 7% | 12/decade |
| HNO3 | 4 km | 400 km | 215—1 hPa | 0.6 ppbv | 1—1.5 ppbv | 6/decade |
| CH3CN | 5.5 km | 500 km | 147—1 hpa | 50 pptv | 100% | 6/decade |
| CH3Cl | 5.5 km | 450 km | 147—4.6 hPa | 100 pptv | 30--50% | 6/decade |
| CH3OH | 5 km | 350 km | Contact MLS | 1 ppbv | 100 % | 6/decade |
| HCl | 3 km | 300 km | 147—0.32 hPa | 0.2ppbv, 50% | 0.2 ppbv, 25% | 6/decade |
| HCN | 10 km | 300 km | 21—0.1 hPa (HCP) | 50% | poor* | 6/decade |
| ClO | 3 km | ~400 km | 147—1 hPa | 0.1 ppbv | 0.2 ppbv* | 6/decade |
| T | 3.7 km | 165 km | 261—0..001 hPa | 0.6 K | 1—2 K | 12/decade |

# CO Timeseries 215 hPa—31 hPa



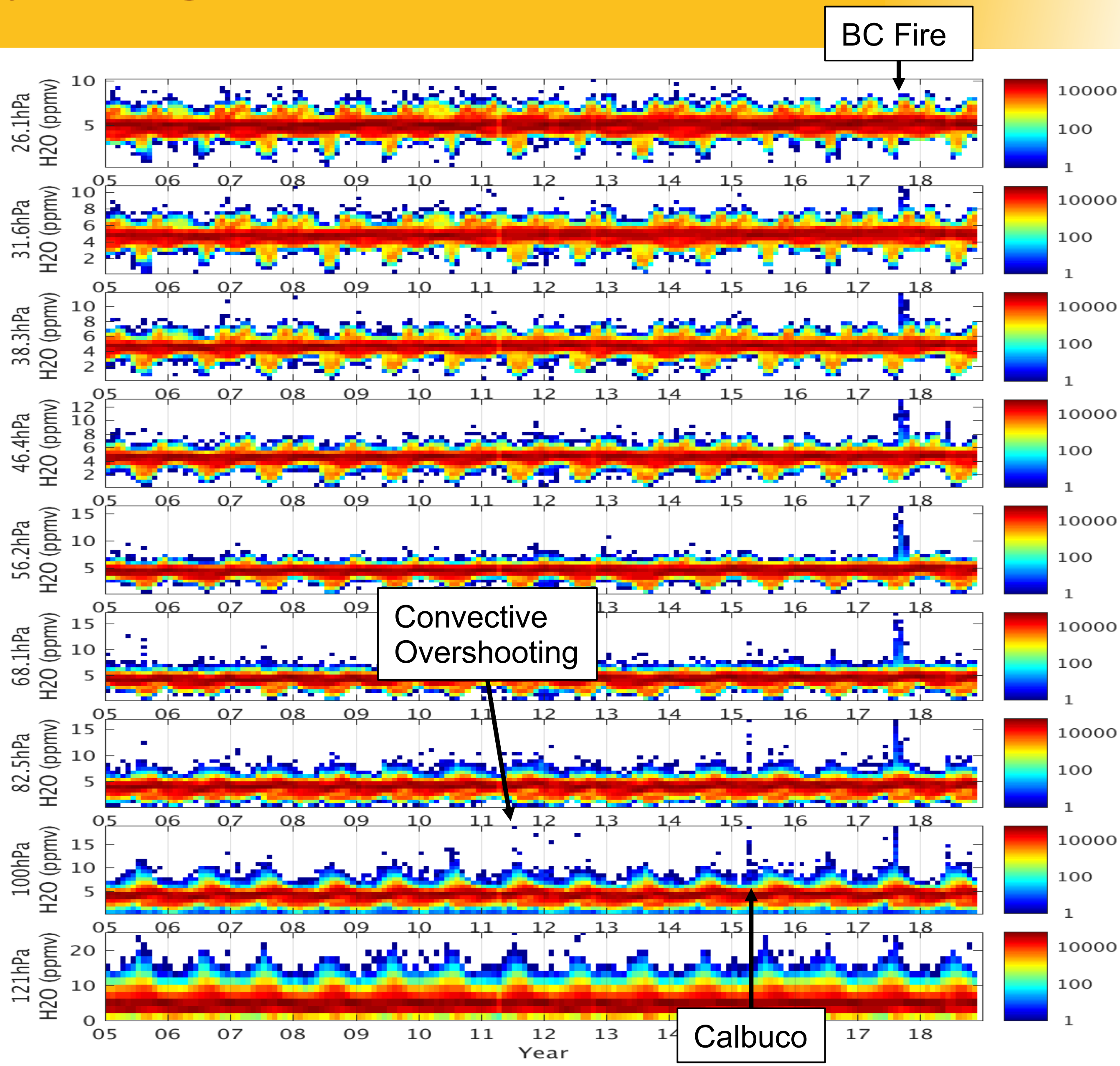



BC Plume

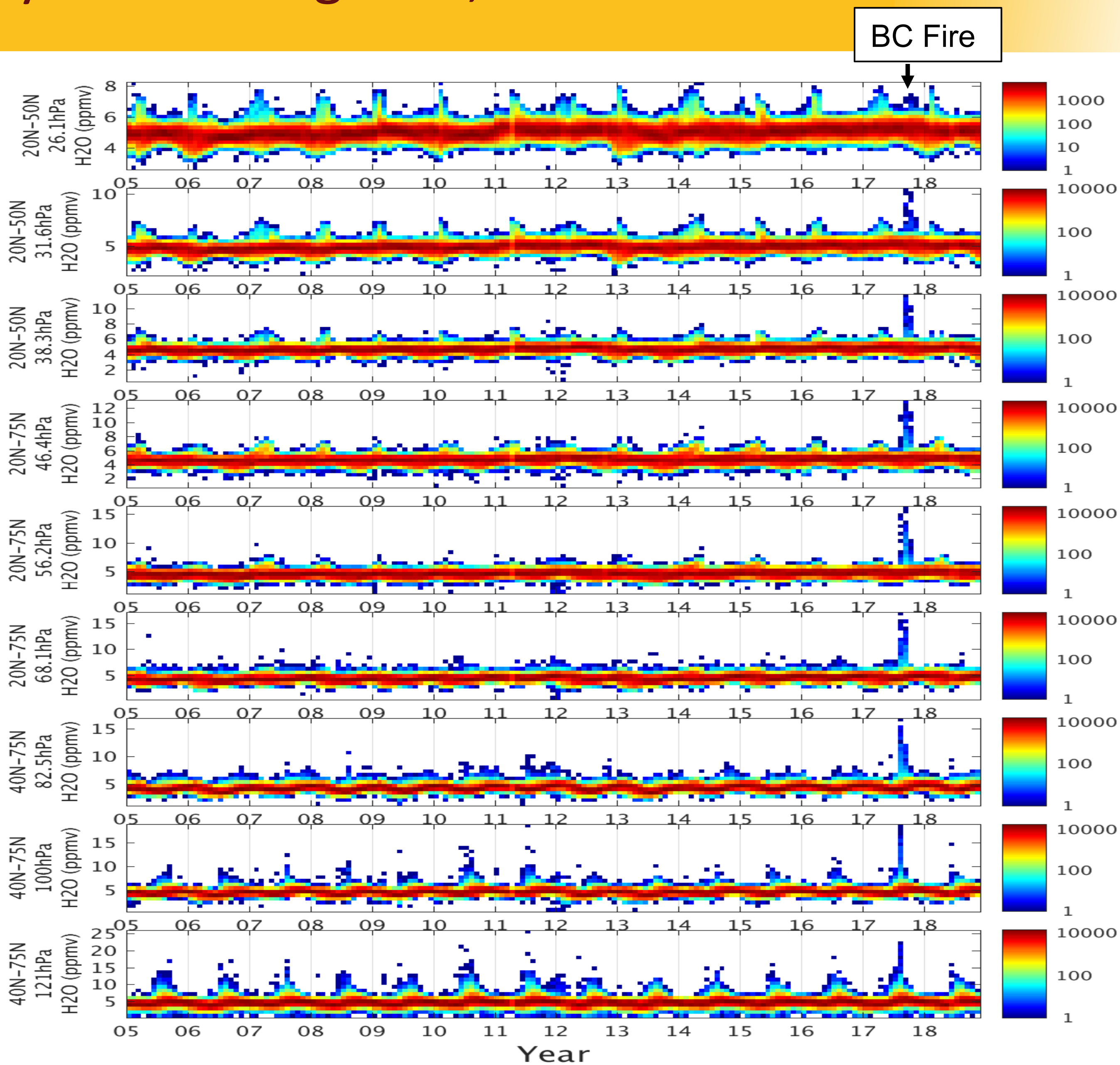
# Monthly Histograms of MLS LS H2O (2005-2018)





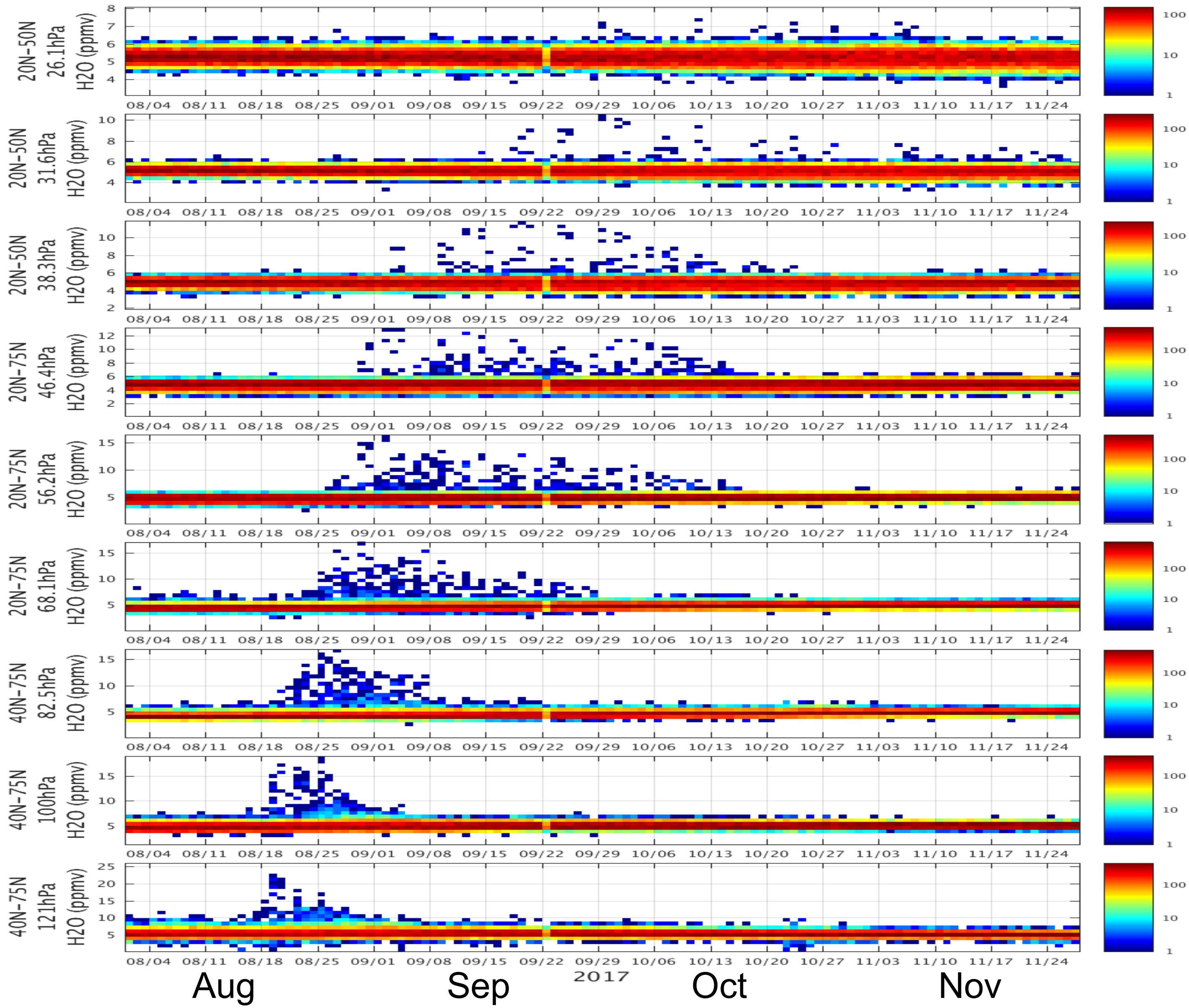
# Monthly H2O Histograms, Restricted Latitudes





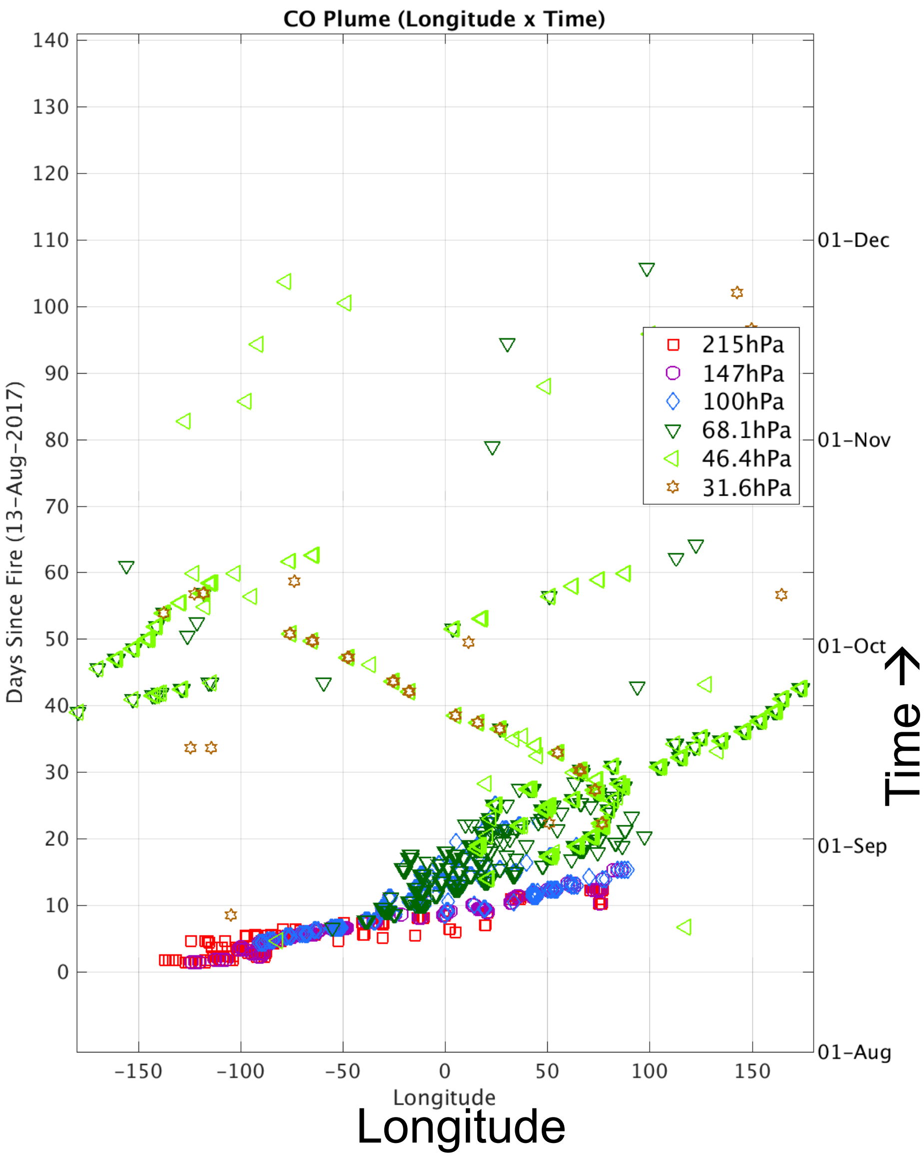
# Daily H2O Histograms:  August-November 2017

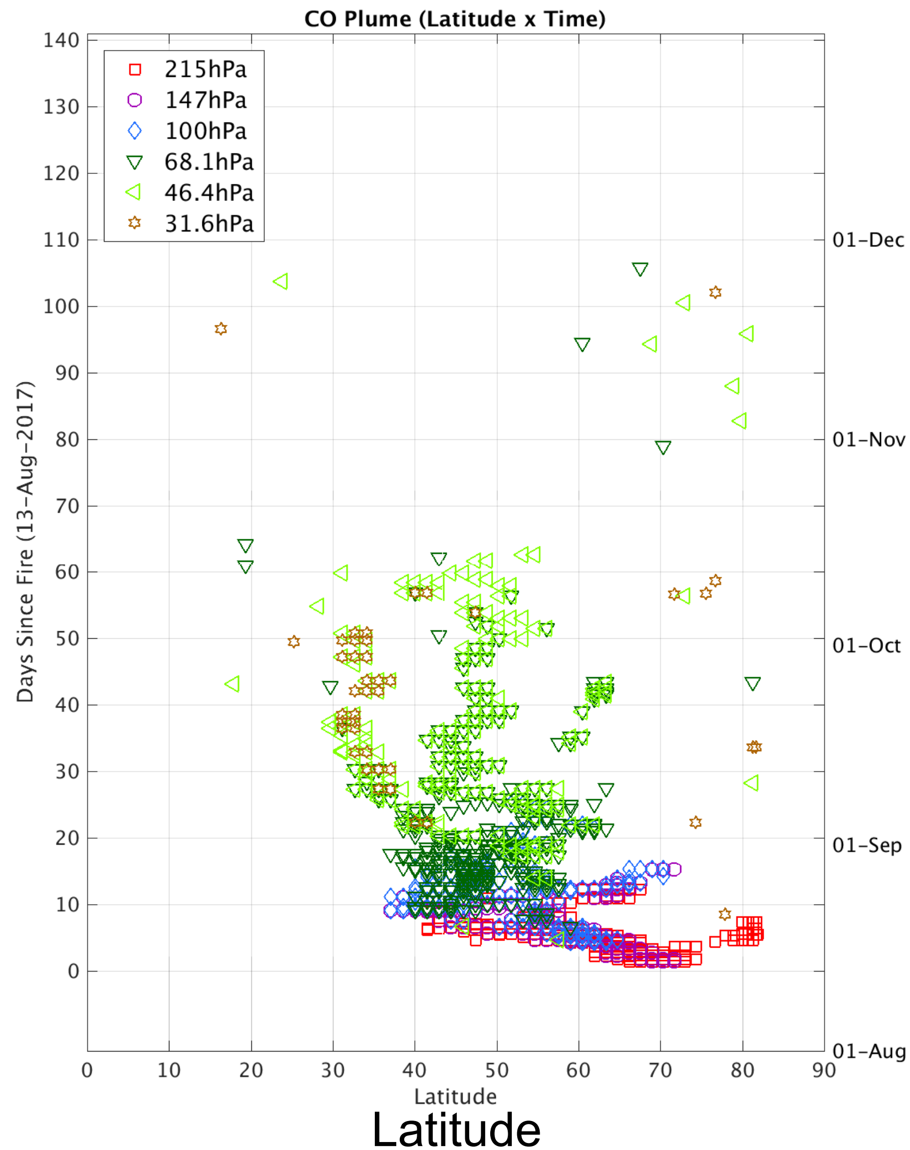




# CO in the 2017 BC PyroCb Plume

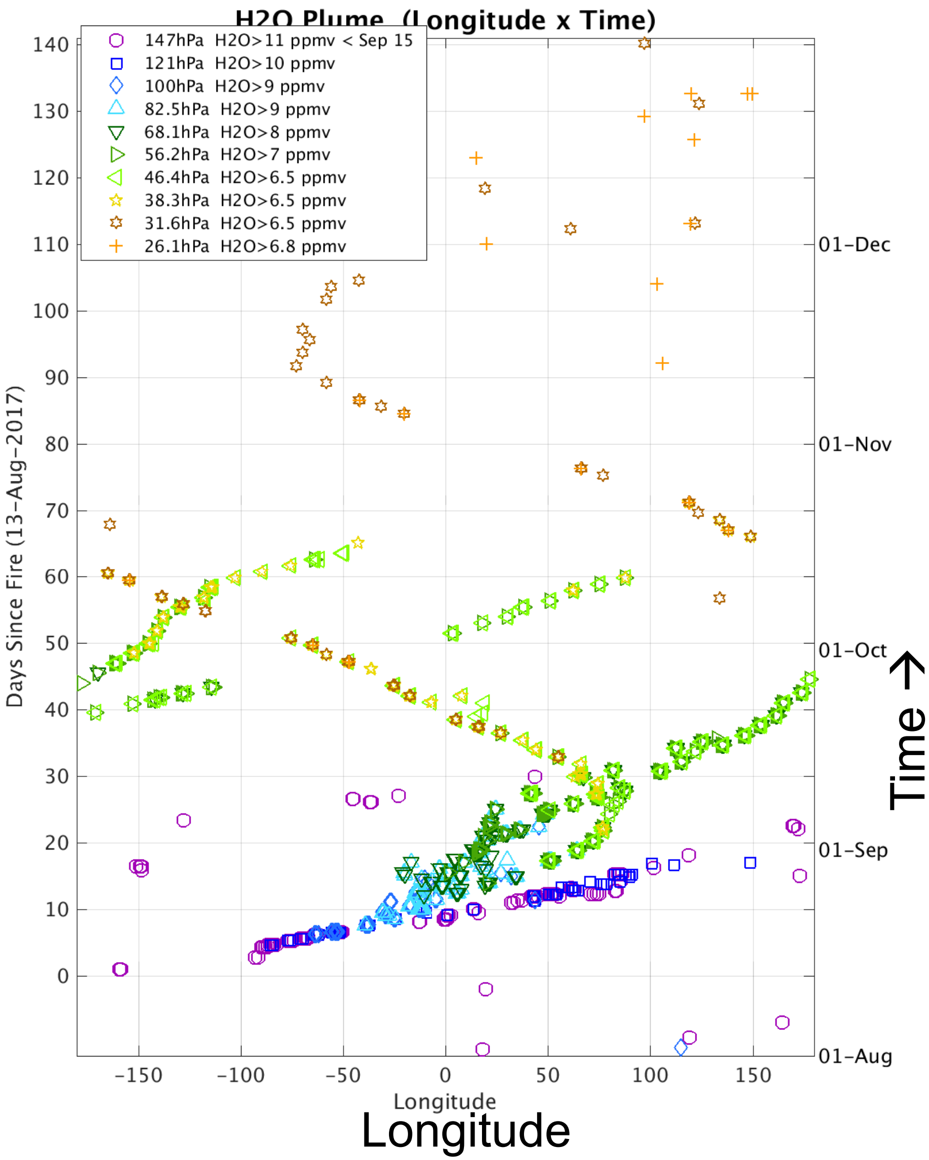


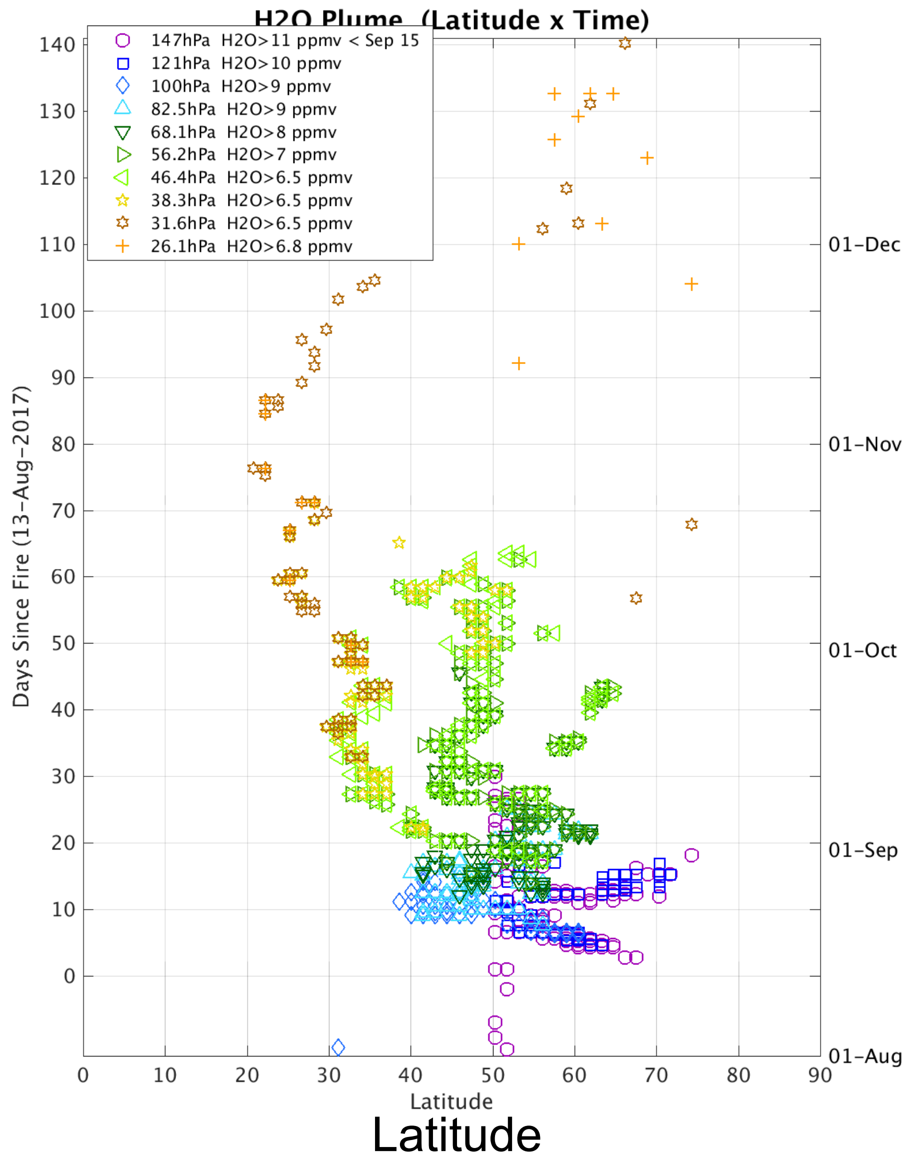


# Water Vapor in the 2017 BC PyroCb Plume

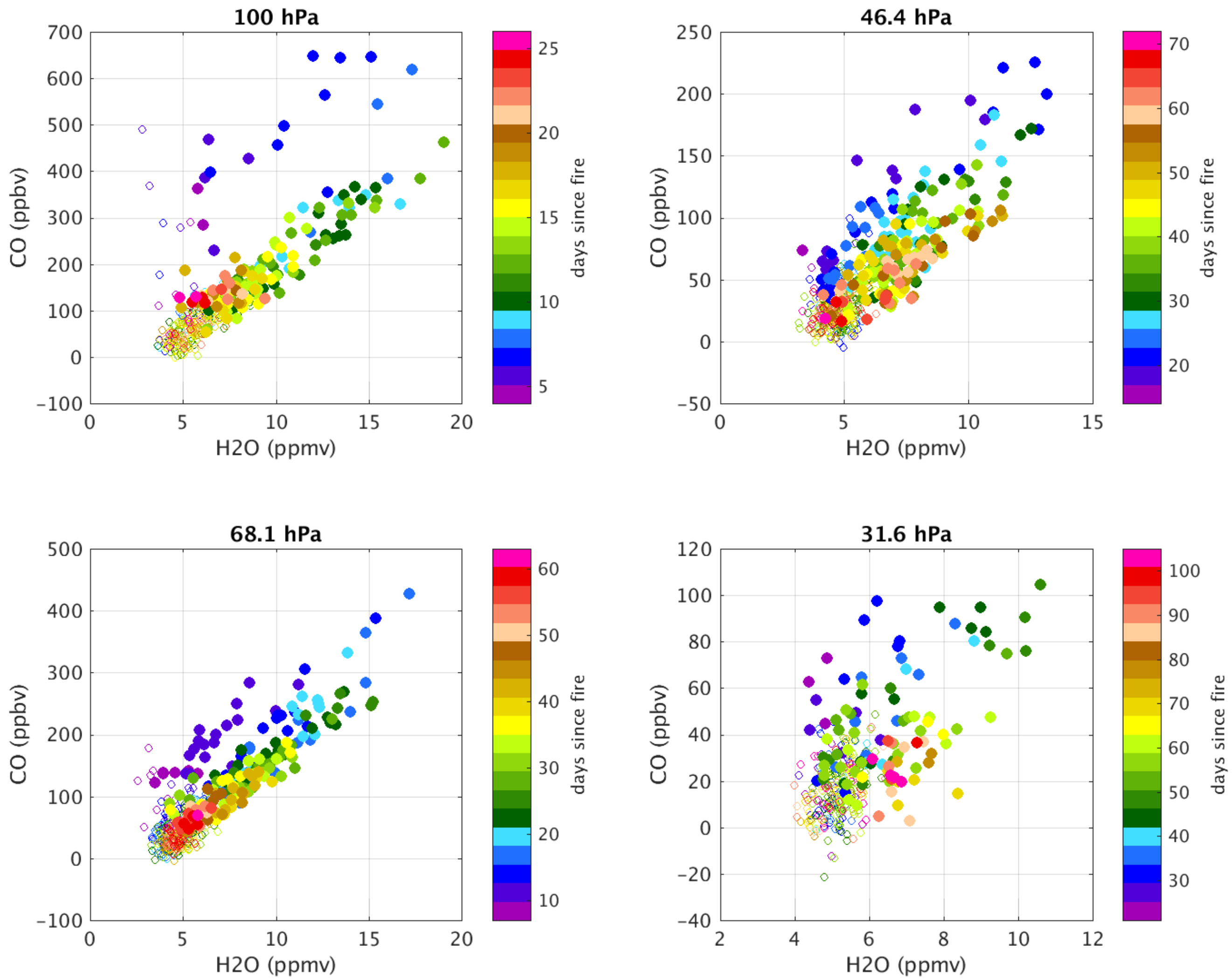




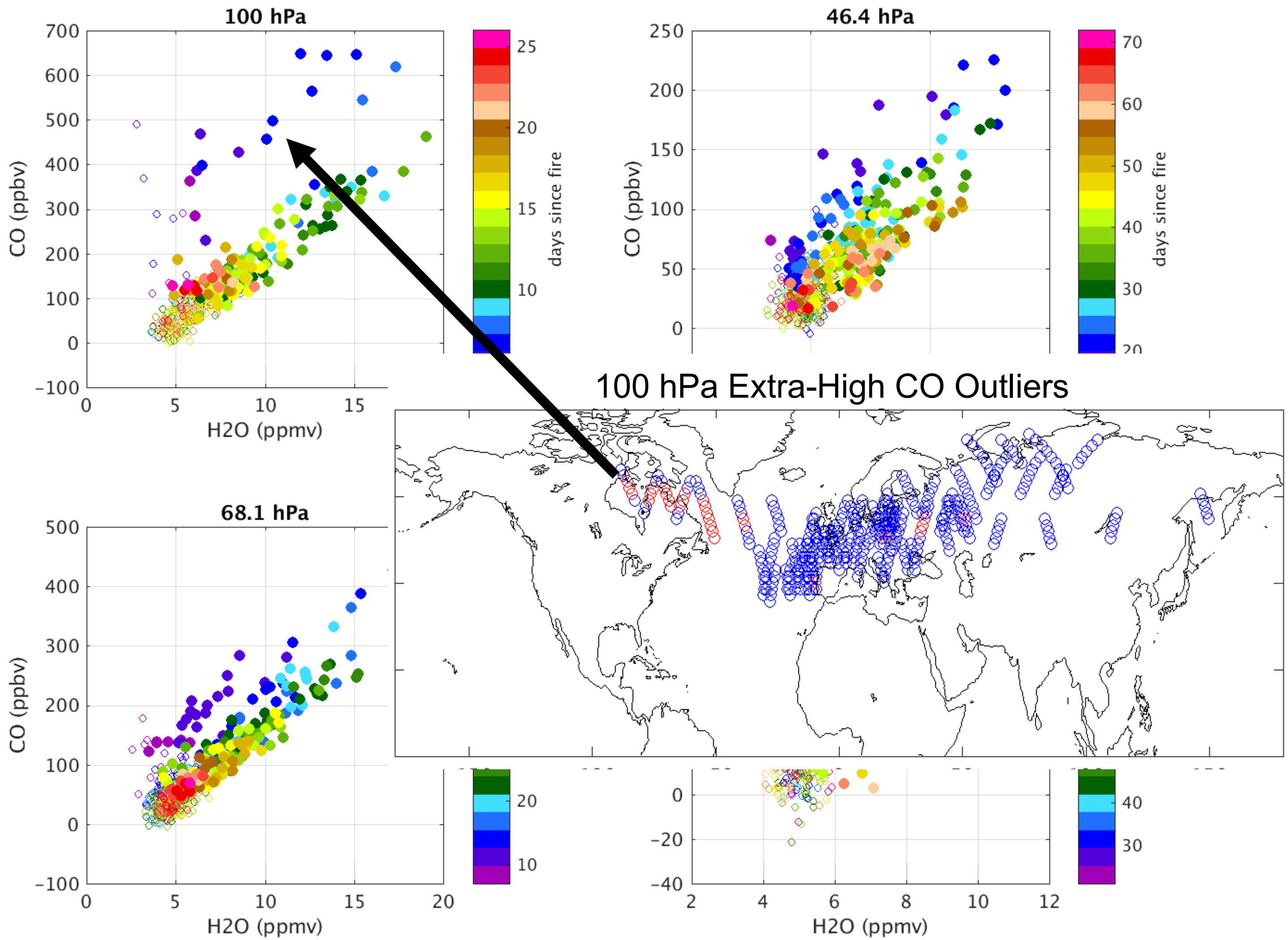
# CO vs H2O Correlation (colored by time since fire)





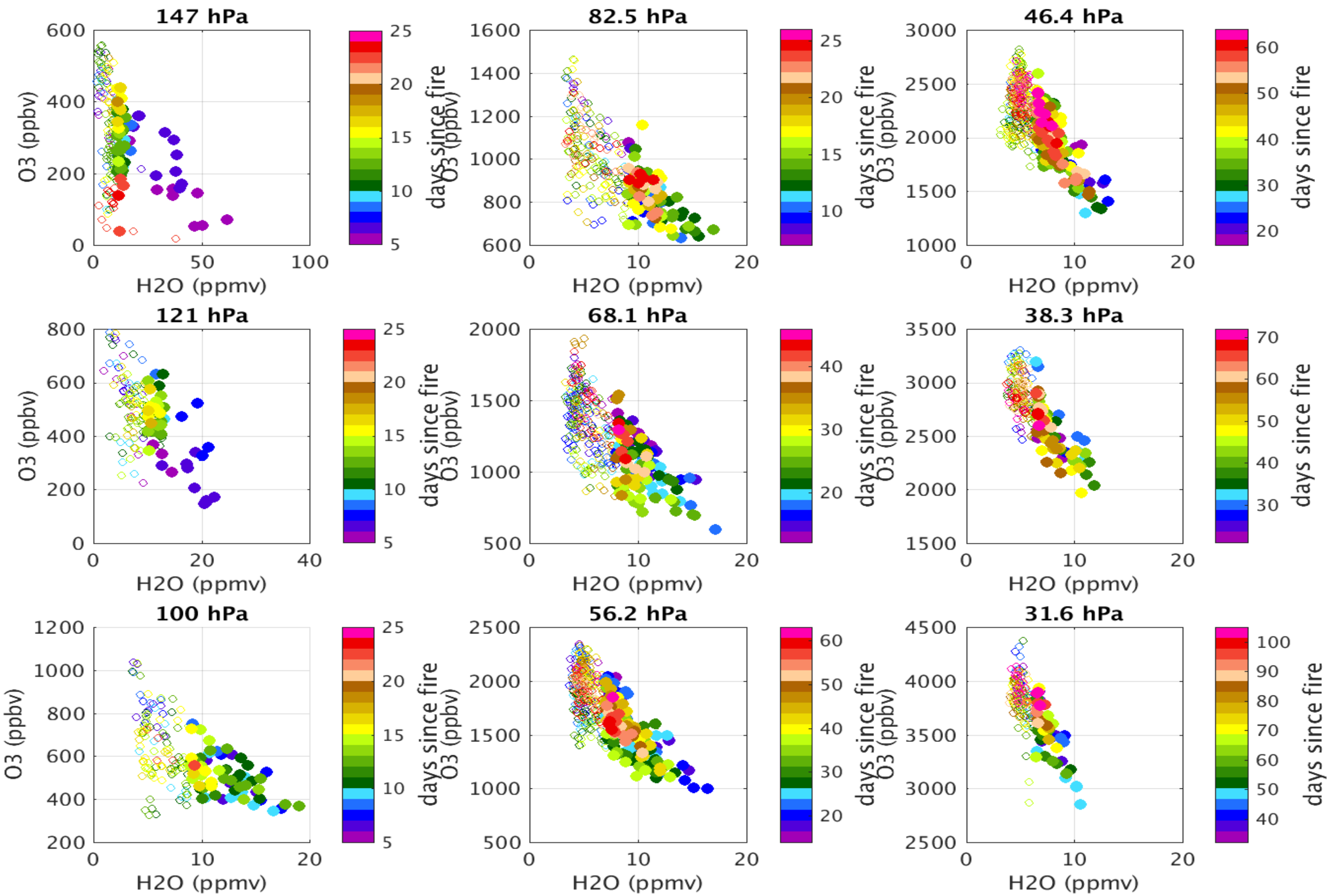
# CO vs H2O Correlation (colored by time since fire)





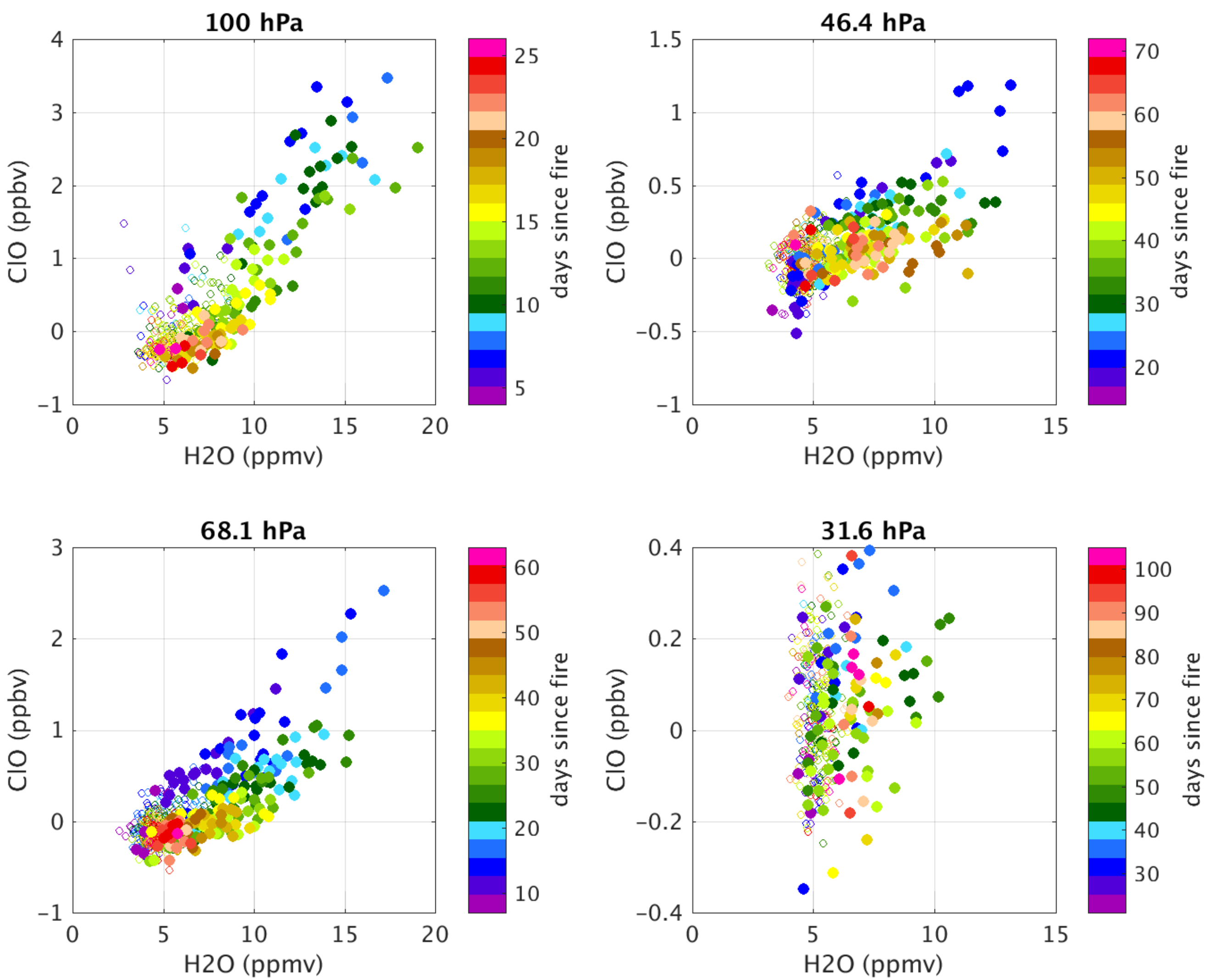
# Ozone vs H2O




147 hPa
82.5 hPa
46.4 hPa
121 hPa
68.1 hPa
38.3 hPa
100 hPa
56.2 hPa
31.6 hPa
O3 (ppbv)
H2O (ppmv)
days since fire

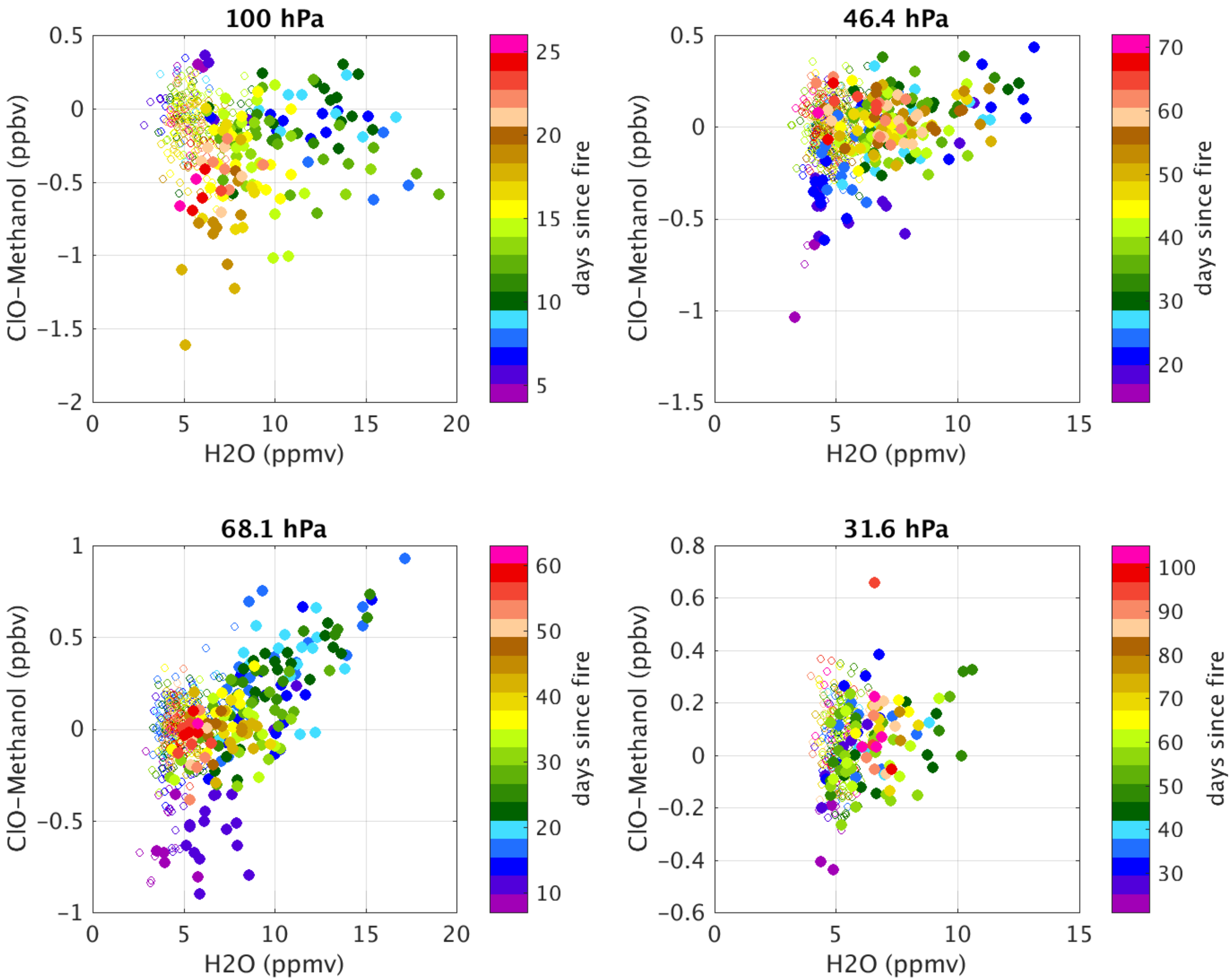
# Plume ClO vs H2O  (640-GHz, CH3OH Interference)





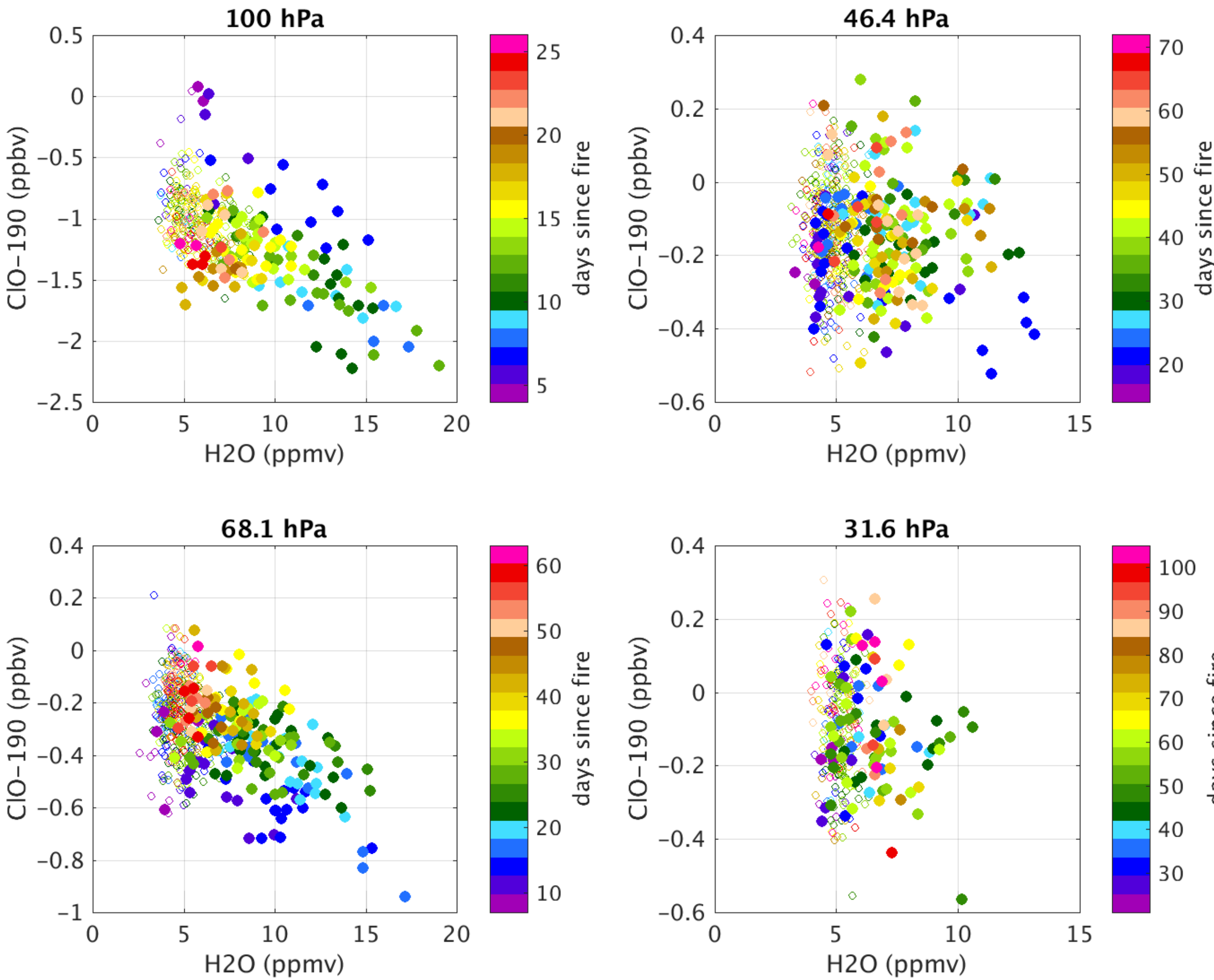
# ClO-Methanol vs H2O  (640-GHz, retrieve CH3OH)





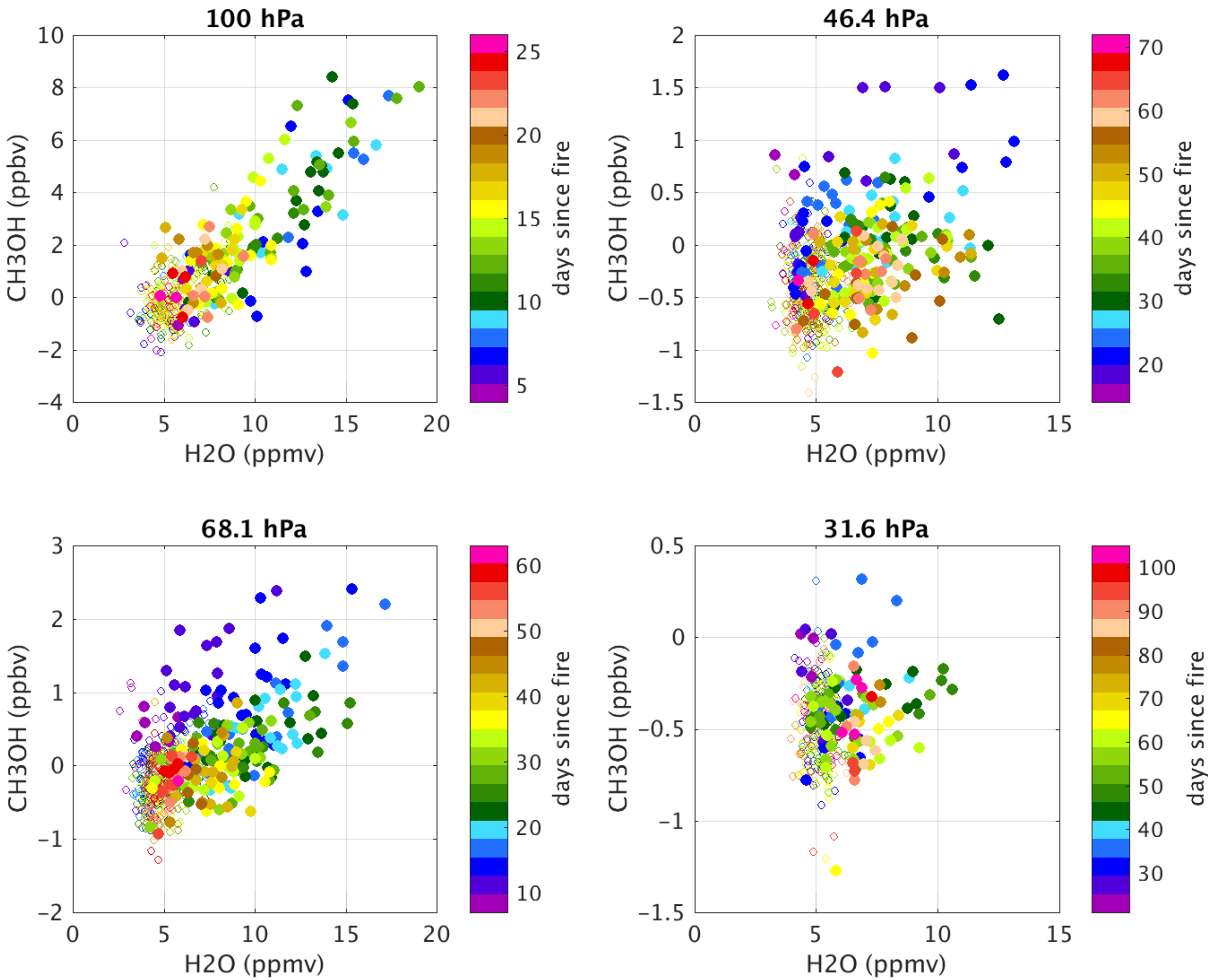
# ClO-190 vs H2O (190-GHz, should show same correlation)





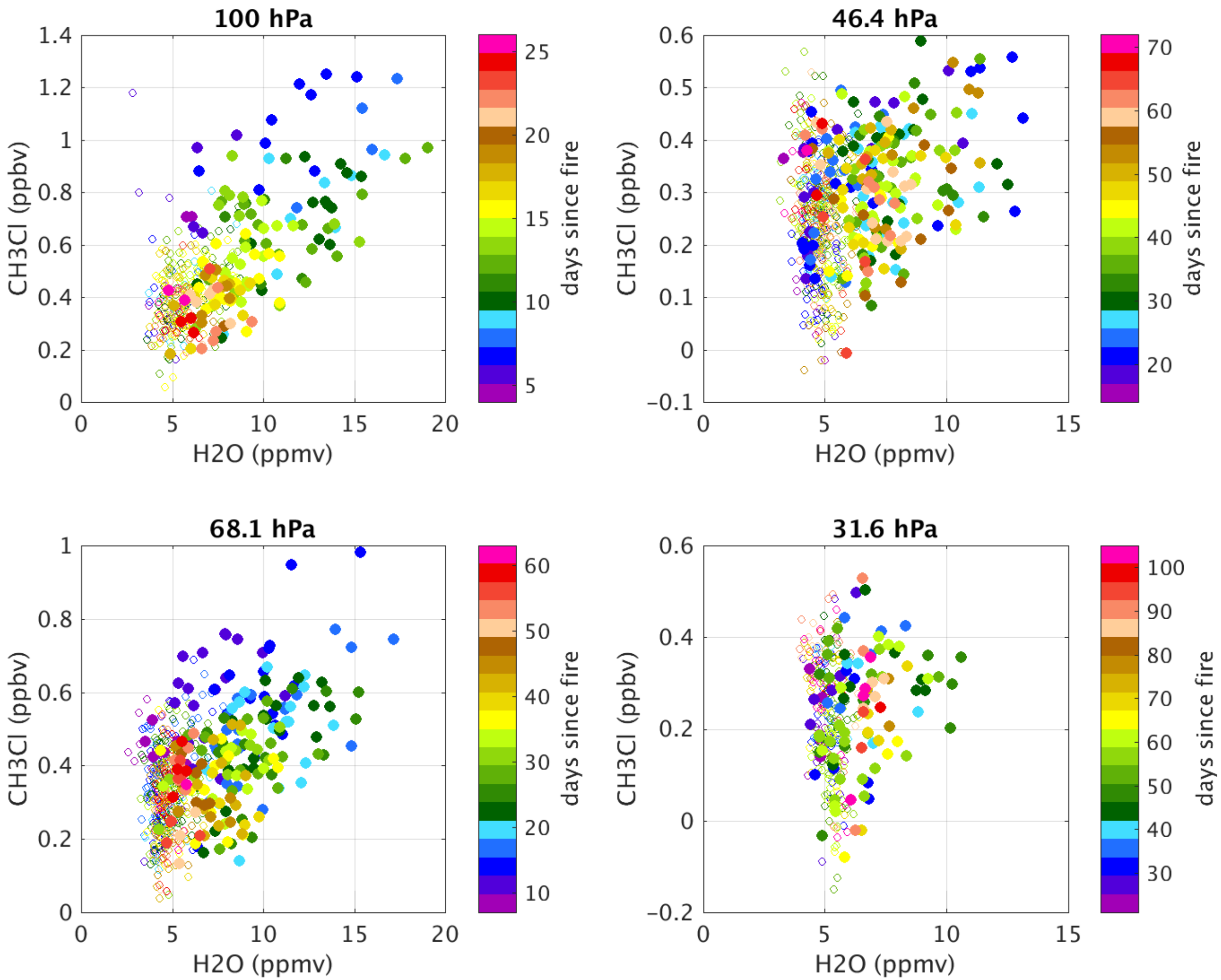
# CH3OH vs H2O




100 hPa
46.4 hPa
68.1 hPa
31.6 hPa
CH3OH (ppbv)
H2O (ppmv)
days since fire

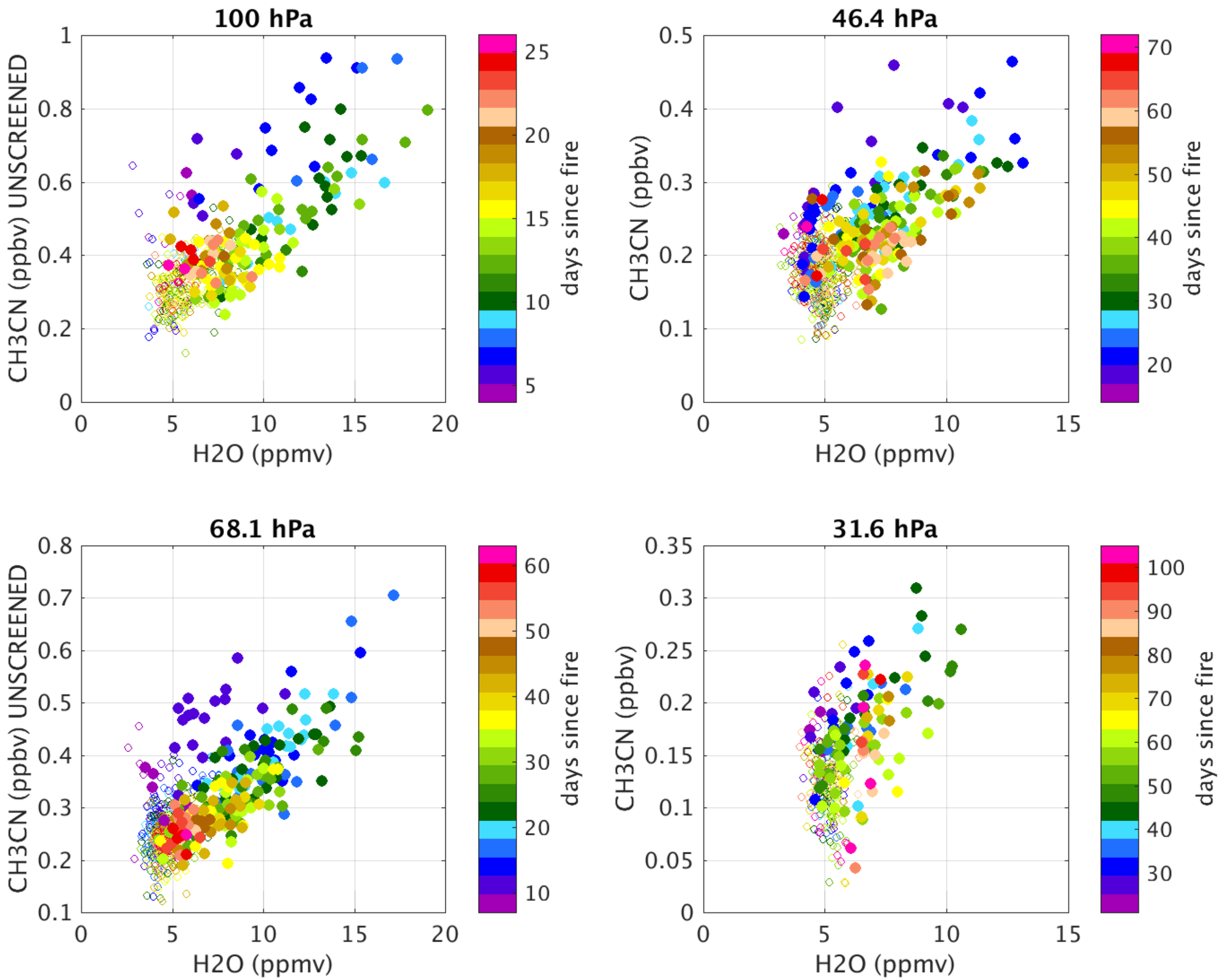
# CH3Cl vs H2O




100 hPa
46.4 hPa
68.1 hPa
31.6 hPa
CH3Cl (ppbv)
H2O (ppmv)
days since fire

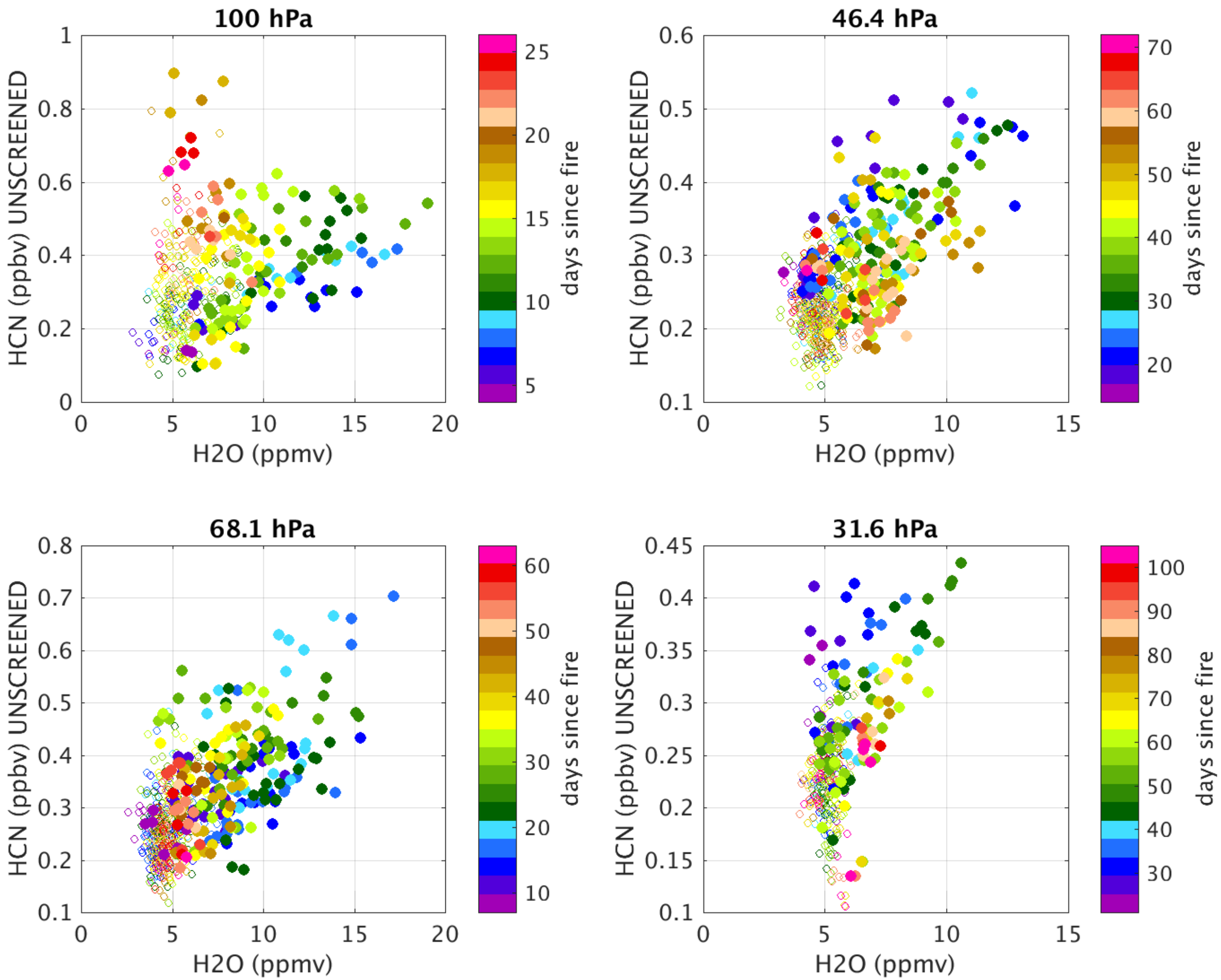
# CH3CN vs H2O




100 hPa
46.4 hPa
68.1 hPa
31.6 hPa
CH3CN (ppbv) UNSCREENED
CH3CN (ppbv)
H2O (ppmv)
days since fire

# HCN vs H2O

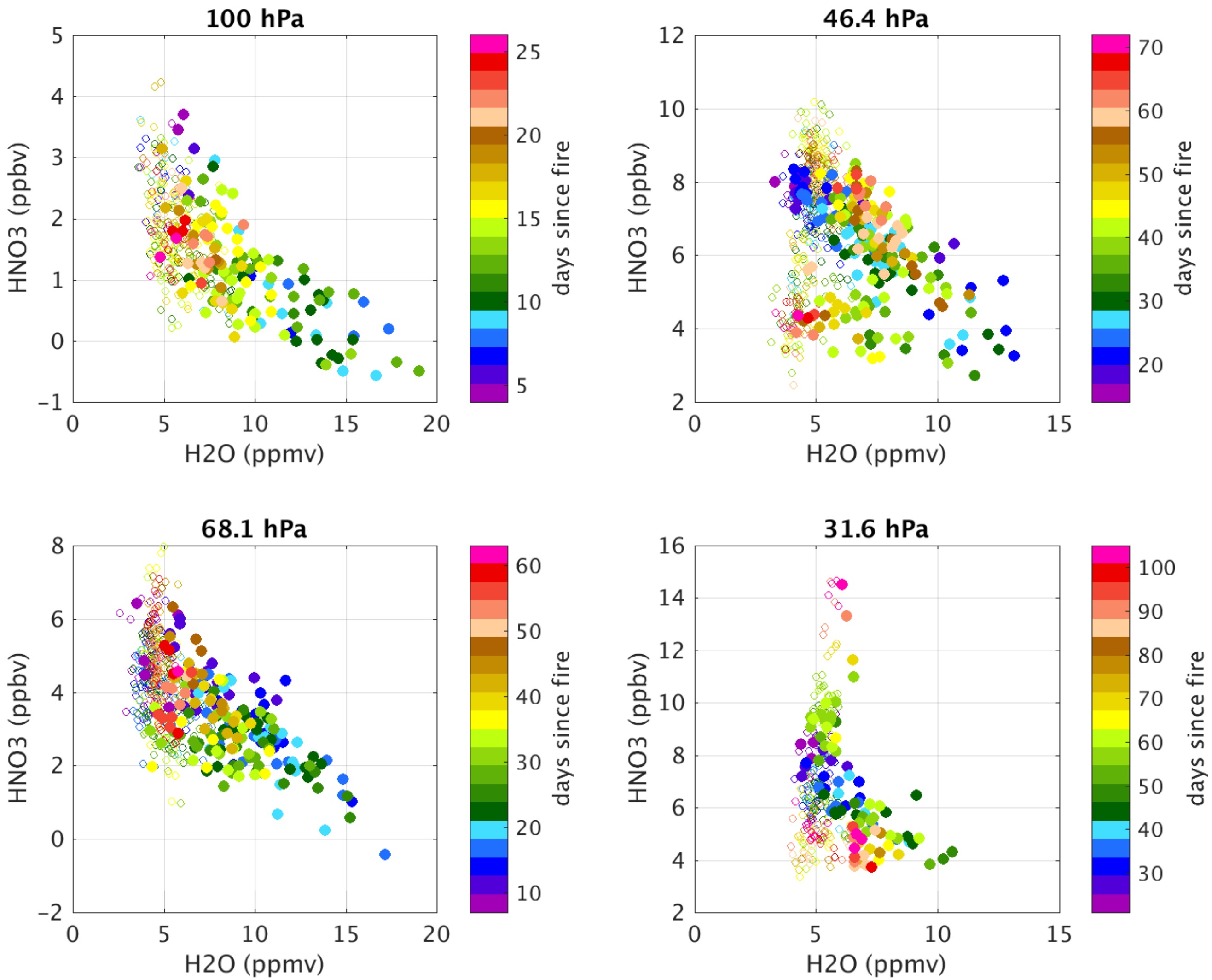




100 hPa
46.4 hPa
68.1 hPa
31.6 hPa
HCN (ppbv) UNSCREENED
H2O (ppmv)
days since fire

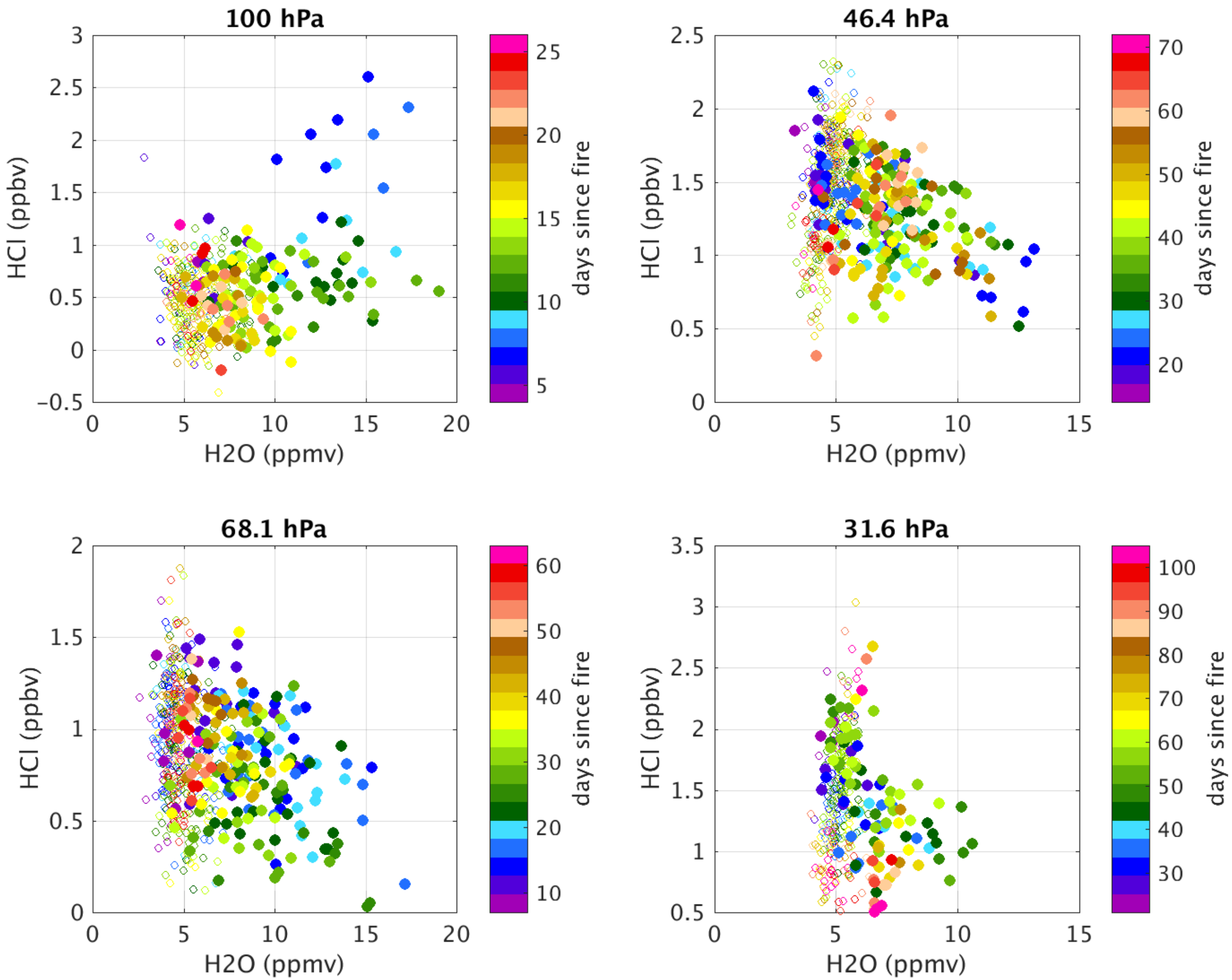
# HNO3 vs H2O




100 hPa
HNO3 (ppbv)
H2O (ppmv)
days since fire
46.4 hPa
HNO3 (ppbv)
H2O (ppmv)
days since fire
68.1 hPa
HNO3 (ppbv)
H2O (ppmv)
days since fire
31.6 hPa
HNO3 (ppbv)
H2O (ppmv)
days since fire

# HCl vs H2O




100 hPa
HCl (ppbv)
H2O (ppmv)
days since fire
46.4 hPa
HCl (ppbv)
H2O (ppmv)
days since fire
68.1 hPa
HCl (ppbv)
H2O (ppmv)
days since fire
31.6 hPa
HCl (ppbv)
H2O (ppmv)
days since fire

# Summary and Further Work



- In the lower stratosphere, CO mixing ratios in the plume are rivaled only by those of the Black Saturday fire of 2009 in the 15-year MLS record, with coherent, elevated plume fragments persisting for >60 days and to 31 hPa.
- H2O mixing ratios at 100—83 hPa are as high as any in the MLS record and at 68—31 hPa are unprecedented, observable for 105 days and to 26 hPa.
- Persistent high water vapor and CO in the plume facilitates investigation of the evolution of correlated MLS trace-gas signatures. Ozone (O3), methyl cyanide (CH3CN), methyl chloride (CH3Cl), methanol (CH3OH), hydrogen cyanide (HCN), nitric acid (HNO3), hydrochloric acid (HCl) and chlorine monoxide (ClO) all have observable signatures. Combustion products are generally enhanced, while stratospheric source gases are generally depleted.
- Further analysis of trace-gas evolution in the plume will leverage a modeling framework (CARMA/CESM) that Pengfei Yu used in his recent Science paper.